



PRESIDENT'S MALARIA INITIATIVE



National IRS Strategy for Mali

Integrated Vector Management (IVM) Task Order 2

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Prepared for:
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Prepared by: Jacob Williams, Director IVM
RTI International
3040 Cornwallis Road
Post Office Box 12194
Research Triangle Park, NC 27709-2194

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MALI

NATIONAL IRS STRATEGY

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TERMINOLOGY

ELISA	Enzyme-linked immunosorbent assay
FAO	The Food and Agriculture Organization of the United Nations
GFATM	Global Fund for HIV/AIDs, TB and Malaria
IVM	Integrated Vector Management
IRS	Indoor Residual Spraying
LLIN	Long lasting insecticide treated nets
LBMA	Laboratoire de Biologie Moleculaire Appliquee
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOE	Ministry of Environment
MRTC	Malaria Research Training Center
NGO	Non-Governmental Organization
NMCP	National Malaria Control Program
PCR	Polymerase chain reaction
PMI	US President Malaria Initiative
PNLP	Programme national de lutte contre le paludisme
RBM	Roll Back Malaria
RTI	Research Triangle Institute
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Schemes

FORWARD

Malaria remains the primary cause of morbidity and mortality in Mali, accounting for 37% of outpatient visits and in excess of 68% of deaths in children less than five years of age. Consistent with the recommendations of the World Health Organization, the government of Mali is orienting towards integrated vector management, as part of a national malaria control strategy, to enhance the scale, cost-effectiveness and impact of disease control efforts. With a national target of reducing malaria mortality and morbidity by 80% in 2015, compared to 2005, the Government of Mali seeks to scale up the two proven vector control interventions of long lasting insecticidal nets (LLINs) and Indoor residual spraying (IRS). Millions of LLINs have been distributed in the last few years, as the country scales up towards universal coverage. Drawing upon lessons from mass IRS spray campaigns in three districts of the country in the last three years, Mali seeks also to scale up the deployment of indoor residual spraying (IRS).

This document proposes a national IRS strategy for Mali. The strategy is outlined within the context of an overarching integrated vector management (IVM) end goal. The IRS strategy is intended to guide subsequent development of a comprehensive and costed national IRS work plan, and will cover all aspects of planning, management, implementation, and monitoring and evaluation of a scaled up national IRS operations. The elaboration of the costed IRS work plan will:

- (i) Focus national action towards cost-effective and sustainable IRS implementation,
- (ii) Contextualize collaboration with, and support by developmental partners within the overarching national strategy, and clarified aspirations and actions of the Government of Mali, and
- (iii) Facilitate resource mobilization by providing a sound basis for structured applications to the Global Fund and other such external funding sources.

1. BACKGROUND: MALARIA/IRS IN MALI

All of the population of Mali, some 15.6 million persons, is at risk of malaria. Malaria transmission is endemic in the south and central districts, where most of the population of Mali resides, and epidemic in the northern districts. Transmission depends on climate and local geography: areas along the Niger delta and in the Sudano-Guinean zone experience year-long transmission, while in the Sahelian Zone in the north transmission lasts from July to October. In 2009, there were approximately 1.6 million episodes of malaria across all age groups. Malaria is the primary cause of morbidity and mortality. It is responsible for 37% of all outpatient visits and more than 68% of deaths in children under five. Eighty-five to 90% of malaria cases are caused by *Plasmodium falciparum*, which is the most deadly species of malaria parasite.

The President's Malaria Initiative (PMI), in collaboration with the National Malaria Control Program (PNLP), began indoor residual spraying (IRS) program in 2008. IRS was carried out in two districts at high risk for malaria (Koulikoro and Bla) in 2008, 2009 and 2010, achieving coverage of at least 89% each year. From 2008 onwards, the numbers of structures sprayed to protect residents from malaria has steadily increased. In 2008, 201,638 structures were sprayed providing protection for 420,580 residents, while in 2009 126,922 structures were sprayed and 497,122 protected from malaria. In 2010, IRS sprayed approximately 127,273 structures in the two target districts, protecting over 440,815 people. IRS will be scaled up in 2011 to cover at least 185,000 structures in three districts (Koulikoro, Bla, and Barouéli) to protect more than 580,000 people. In some areas, other private organizations and companies also conduct focal IRS operations for malaria control, although these are mostly not well regulated.

The availability of insecticide-treated nets (ITNs) has also increased throughout Mali: In 2006, the Demographic and Health Survey showed that 50% of households owned at least one ITN, with only 27% of children under five and 29% of pregnant women, sleeping under an ITN the night before. In the succeeding years ITN coverage has been scaled up. A PMI campaign survey in 2008 indicated that 83% of households owned at least one ITN, and 78% of children under five years and 74% of pregnant women, slept under a net the previous night. The National Malaria Strategic Plan indicates an objective of universal coverage with long-lasting insecticidal net (LLIN) – defined as one LLIN for every two people. The 2011 gap in LLN coverage is

estimated at nearly five million. About 1.54 million LLINs are planned for procurement by PMI for distribution in 2011 calendar year, with an additional amount of 1.55 million more LLINs in the following year.

To achieve the national objectives on malaria vector control coverage:

- i. The deployed interventions must be cost-effective and sustainable.
- ii. Relevant capacities (human, infrastructure and managerial) will have to be developed at all levels of program administration (national, regions and counties) to (a) generate local data required to inform sound deployment and evaluate the impact of the intervention to allow further refinement, and (b) better manage threats to the continued utility of IRS (e.g. insecticide resistance in local mosquito vectors).
- iii. An appropriate regulatory environment will have to be established to ensure effective control of insecticides, product quality and adequate human and environmental safeguards in the handling, use and disposal of public health insecticides.

Strategic Objective:

The current national malaria control strategy of Mali has an objective of reducing morbidity and the mortality due to malaria by 80% in 2015 (compared to 2005). Further to this, the overall objective of the national IRS strategy is:

- To scale up well-targeted, efficient and cost-effective IRS operations to protect at least 40% of the population at risk of malaria by 2015, based on sound local evidence on disease eco-epidemiology.

Specific Objectives

- a. To deploy an aggressive and evidence-based IRS operation, beginning in the endemic and high burden areas, to disrupt transmission and accelerate reduction of local disease burdens [**Phase 1 of national scale up**].

- b. To extend IRS operations into more challenging areas of epidemic prone regions, as national capacity for epidemic prediction and preparedness is enhanced and lessons and experiences on IRS operations are consolidated [**Phase 2 of national scale up**].
- c. Establish an effective mechanism to manage the development of insecticide resistance among the local malaria vectors, to ensure the continued utility of the WHOPES approved insecticides, and the long term viability of IRS in Mali.

2. IRS AND INTEGRATED VECTOR MANAGEMENT

The deployment and scale up of IRS in Mali will be done within the context of a national strategy on Integrated Vector Management (IVM). IVM is the recommended approach for the cost-effective and sustainable control of the vectors of human diseases such as malaria (WHO 2010). It is defined as “*a rational decision-making process for the optimal use of resources for vector control,*” is.

Mali is initiating efforts to adopt the integrated vector management (IVM) approach for malaria control. As part of the process, a vector control needs assessment (VCNA) is being conducted. The VCNA will review the current framework and status of vector control and identify existing constraints to achieving set national objectives. It will also identify opportunities and requirements for resolving the constraints and increase efficiencies in order to maximize sustainable reductions in disease burdens.

IVM provides a proven framework for developing IRS strategies and organizing implementation activities. The areas of IRS alignment with the five elements of the IVM framework are listed in Table 1 and elaborated in succeeding sections.

Table 1: Application of IVM Elements to the organization of IRS

IVM Element	Summary scope	Application to IRS Operations
Legislation	<ul style="list-style-type: none"> • Regulatory and legislative controls for public health and pesticide management well established, reviewed and kept relevant 	<ul style="list-style-type: none"> • Assure adequate and up to date national insecticide legislation and regulations to safeguard human health and environment • Establish appropriate taxes and tariffs regimes to promote IRS
Advocacy/social mobilization	<ul style="list-style-type: none"> • IVM principles embedded in development policies of all relevant agencies, organizations & civil society 	<ul style="list-style-type: none"> • Advocacy/communication on IRS targeting policy makers, implementers, communities and other stakeholders including donors to foster favorable policy environment
Cross sector collaboration	<ul style="list-style-type: none"> • Functional collaboration within and between public and private sectors. Effective channels of communication among policymakers, VBD control programs and partners 	<ul style="list-style-type: none"> • Establish fully mandated national and subnational mechanisms for consultations, joint planning and implementation by stakeholders, with clearly defined roles/responsibilities
Capacity building	<ul style="list-style-type: none"> • Essential physical infrastructure, financial resources and adequate human resources developed at all levels to manage local vectors 	<ul style="list-style-type: none"> • Identify range of skills/competencies, staffing levels and location for effective IRS operations • Establish trained human resources; mobilize relevant cross sectoral capacities Establish requisite infrastructure for IRS • Establish and integrated vector control information system with national disease (malaria) information system
Evidence-based decision making	<ul style="list-style-type: none"> • Strategies and interventions adapted to local ecology, epidemiology and resources, guided by routine monitoring and evaluation and operational research and 	<ul style="list-style-type: none"> • Clarify information needs, indicators and data collection methods • Establish entomological and epidemiological monitoring plans for targeting, monitoring and evaluation • Select insecticide based on local knowledge on vector susceptibility/resistance • Assure timeliness and completeness of data; manage and utilize evidence for decisions on IRS implementation and strategy refinement
Integrated approaches	<ul style="list-style-type: none"> • Rational utilization of available resources, including appropriate integration of vector tools and methods and multi-disease control approaches. 	<ul style="list-style-type: none"> • Clarify/justify IRS target areas within a national IVM context, utilizing generated local evidence • Assure adequate and evidence-based guidance on combinations with LLINs, short-term impact and long-term disease control objective

2a. Legislation and regulatory mechanisms

The use of public health insecticides must be fully regulated to ensure adequate protection of human health and the environment. The adequacy of existing national legislation and regulations covering the use of public health insecticides in general and particularly those relevant to IRS, will be evaluated. Where gaps and weaknesses are identified, these will be remedied as part of national preparations for scaled up intervention. Modalities for registration, licensing and importation of WHOPES approved insecticides for IRS will be further streamlined to ensure vendors are equipped to relay appropriate information on the insecticide and remove bottlenecks that may delay consideration of newly approved insecticides, especially in relation to the harmonized regional framework under CILSS (*Comité permanent Inter-état de lutte contre la sécheresse dans le sahel*) and the CSP (*Comité sahelien des pesticides*).

Potential risks to human health and the environment in the use and national scale up of IRS will be comprehensively assessed and safeguards will be established in compliance with national regulations, as well as relevant recommendations of the WHO and FAO (e.g. *International Code of Conduct on the Distribution and Use of Pesticides*). The evaluation will include potential risks within any targeted geographical/ecozone (e.g. riverine), rationale for the selection of insecticide, potential risks in handling and judicious use of the IRS insecticides. Provisions will be made for effective enforcement of regulations and established safeguards, including the creation of appropriate educational, advisory, extension and health-care services. Anticipated safeguards will include the following considerations:

- a. Updating and harmonizing relevant laws, regulations and institutional arrangements, as necessary, to protect human health and the environment in IRS operations. This will include realistic modalities for communication between enforcement agencies and program implementers and clarifying and broadcasting penalties for breaking laws regulating the use of insecticides and restricting access.

- b. Mandating that WHOPES approved insecticides will be used for IRS, with full compliance with recommended formulations.
- c. Insecticides for IRS will be procured from internationally recognized/ certified manufacturers or their certified local agents; there will be transparent and verifiable import shipment and chain of custody in-country; country capacity for assuring the quality of the active ingredient of procured insecticides will be enhanced. Establishing local capacity for testing or validating active ingredient and formulation will be a medium to longer term goal.
- d. Training of all categories of IRS workers on best practices in accordance with national regulations and recommendations of WHO and FAO in the handling (storage, transportation, end-use and disposal) of insecticides.
- e. Warehousing capacity will be established in the districts for the IRS supplies and equipment to facilitate logistics management. Pesticide storage and inventory practices will be established. A certification scheme will be established for all insecticide application equipment as well as spray operators.
- f. Strict use of personal protective equipment by all IRS workers who directly handle IRS insecticides.
- g. Stringent procedures will be outlined to enforce compliance of safeguards, including use of trained environmental compliance inspectors at all level.
- h. Equipping select health facilities as reference points for insecticide poisoning and training of relevant health workers to manage incidences of poisoning.
- i. Standardized procedures, such as rinse water recycling to minimize effluent and the use of soak pits or concrete evaporation tanks depending on the insecticide selected. The positioning of soak pits will meet set environmental consideration with regards to non-proximity of river or underground water, and restricted access.
- j. Environmentally sound disposal procedures for insecticide contaminated waste and packaging.

Taxes and Tariff adjustment to promote IRS

The Abuja Declaration of April 25, 2000, by African heads of state, advocated the elimination of taxes and tariffs on anti-malaria commodities to enable sustainable disease control. Mali has eliminated taxes and tariffs for bednets, anti-malaria medicines and RDTs. However, taxes on insecticides, IRS pumps and personal protection equipment for IRS still remain. The Government of Mali will, as necessary, review these to promote rapid scale up of IRS operations.

2b. Advocacy and Social Mobilization

Lessons from the current IRS operations will be drawn to inform the advocacy and communication efforts linked to the scale up of IRS implementation. IRS will thrive when appropriate policy environment is created and sustained and targeted communities are empowered to proactively engage in IRS efforts. This is best done with well-designed and executed advocacy strategy. The NMCP will provide leadership for, and coordinate advocacy and communication on, IRS with advice/input from communication outfits within the MOH and other sectors, as necessary. There is a broad range of advocacy and mobilization targets in IRS, including:

- *Policy makers*: Advocacy and communication to this group is purposely to solicit buy-in and support for the intervention, as IRS operations require recurrent annual budget allocation. Communication will be succinct and well-tailored and will cover the role benefits of IRS in malaria control; contextualize potential risks and clarify safeguards; clarify funding requirement; and summarize experiences and lessons from implementation with direct policy implications.
- *Donors and developmental partners*: Advocacy to this group will communicate the national strategy and goals for malaria control and the role of IRS towards achieving the goals; targeted population that will be protected through IRS; implementation experiences and

impacts, fund mobilization and gaps. The target may be within as well as external to the country.

- IRS target communities and general public: This is usually conducted through various public news media, public fora with communities, as well as visits of trained IEC/BCC communicators to individual households. The messages will be translated into local dialects, as may be necessary. The intent will be to inform the general public about the IRS intervention and the purpose; explain the anticipated role of household occupants, including actions to reduce exposure, and clarify misconceptions. The goal of communication is to promote buy-in from the targeted community and maximize acceptance rate. Communication to communities targeted for IRS will be timed to lead into and synchronize with field operations.
- Technical staff: At the central, district and community levels of program administration: the character and content of information will depend on the objective of the message and whether it is intended to mobilize the technical staff to undertake any of the advocacy/communication aforementioned. In addition, level-appropriate technical information will also be communicated directly to and from the various levels to support decision making at the various program administration levels (Fig 1).
- Other stakeholders (e.g. private sector): Advocacy/communication to this target group will be aimed at clarifying the IRS intervention, along with its place and role in malaria vector control. It will also aim at soliciting stakeholder participation. For the private sector, an additional possible goal will be to either solicit direct contribution to the national program (financial, technical supplies) or the initiation of private sector driven IRS operations as part of “corporate social responsibility” efforts, to protect staff or nearby townships.

2c. Cross Sectoral Collaboration

A robust cross sectoral collaboration is necessary for effective malaria vector control and is seen as critical to the successful implementation of the national IRS strategy. There is currently

a national level Steering Committee which functions under the auspices of the PNLP to coordinate partner effort and guide implementation of malaria control activities. This committee will be strengthened and properly mandated to better facilitate and coordinate stakeholder action. There will be clear definition of sectoral/stakeholder functions and roles to foster transparency and accountability in collaboration. The potential mandate of the National Steering Committee is outlined in Box 1. The following stakeholders are considered particularly vital for IRS operation:

- *Ministry of Environmental (MOE):* With its mandate, the Ministry is well positioned to support robust environmental safeguards in the handling, storage, use and disposal of IRS insecticides. Currently the MOE reviews and approves the environmental assessments covering IRS operations. It also provides field inspections during IRS operations to ensure strict compliance with safeguards.
- *Ministry of Agriculture:* The Ministry of Agriculture is mandated to regulate the registration, importation and use of pesticides in Mali. Hence it is a major stakeholder of PNLP/ MOH. For insecticides such as pyrethroids, that have shared use in both agriculture and public health, coordination between the two ministries is critical to the overall national strategy to promote judicious use and to manage the development of resistance in the local mosquito vectors of malaria. The extension service infrastructure of the Ministry of Agriculture will be critical in the efforts to promote

BOX 1 Potential Terms of Reference for National Cross-Sectoral Committee

- Review national policies relevant to vector borne diseases and develop a unified overarching national policy and strategies for their control
- Coordinate and provide oversight to the implementation of national IVM strategy and work plans, ensuring cost-effectiveness, efficiencies, and sharing of lessons/experiences
- Coordinate the mobilization of resources for intersectional action consistent with national aspirations for VBD control ensuring transparency and accountability
- Facilitate rationalized roles and responsibilities among stakeholders and evolve mechanisms to promote/ensure accountability.
- Undertake regular review of the implications of policies, strategies and work plans on VBDs and make recommendations to Government and appropriate authorities to enhance the achievement of national objectives.
- As may be required, constitute working groups drawing upon national and international expertise to address priority issues of concern
- Create opportunities for generating broad-based national consensus on issues and ensure that the genuine concerns of risk populations and communities are adequately considered.

judicious use of insecticides among farming communities.

- *Ministry of Urbanization*: With the mandate to regulate human settlements and urbanization, the inclusion of this stakeholder will enable more comprehensive malaria control safeguards and intervention strategies particularly within peri-urban and other settlement areas where malaria risk is elevated.
- *Research Institutes*: Research outfits, such as the Malaria Research Training Center [MRTC] and Laboratoire de Biologie Moléculaire Appliquée (LBMA), will continue to have central roles in supporting entomological and epidemiological surveillance and monitoring. Modalities will be established to ensure that the excellent capacities of these institutes are better harnessed to assist with routine monitoring activities needed in IRS operations and wider IVM efforts.
- *Developmental Partner Organizations* – Organizations such as WHO, UNICEF, Global Fund, PMI/USAID, which are actively partnering with the government of Mali on malaria control, will play a critical role in the overall effectiveness and sustainability of scaled IRS implementation.

2d. Capacity Strengthening

Human Resource

As part of ongoing national orientation towards IVM, a VCNA is being conducted, which will evaluate the range of competencies, skills and staffing required at the various levels of malaria control administration (National, District and sub-District) to efficiently manage local malaria vectors. The review will also include needs for overseeing a rapid national scale-up of IRS.

Human resource strengthening for IRS will target developing the various skills and competencies that will enable efficient performance of desirable core functions at the various levels of malaria control administration (ref. Table 2). The PNLP will work towards ultimately building a national infrastructure that enables some decentralized decision-making and that places some vector control decisions appropriately closer to affected/targeted communities.

At the Central Level, a Vector Control Unit will be created within the PNLP to lead the coordination and implementation of IRS and other malaria vector control activities. This Unit will receive progressive training on the management of IRS operations, as part of a wider training on IVM. Opportunities for coordinating existing human resource assets within PNLP and the broader MOH will be aggressively pursued to establish a full and complementary skillset in entomology, epidemiology, procurement and logistics management, general vector control, and data management, as well as program monitoring and evaluation. Opportunities for enhancing the inclusion of competencies/capacities of other relevant sectors, such as Ministry of Environment, will be aggressively pursued.

Staffing and relevant competencies at the district and sub-district levels will be strengthened to facilitate a longer term goal of decentralizing some of the core functions, as outlined in Table 2. Vector control coordinators will be established at all the districts and capacitated to enhance the coordination of malaria control activities. The capacity to correctly quantify procurement needs (insecticides, spray equipment, and spray team sizes, based on housing and population data) is vital to the success and timeliness of spray campaigns and is best done from the districts and accumulated up at the central level.

Table 2: Desirable Core Functions at different levels of National Vector Control Program

National/Central Level	
<ul style="list-style-type: none"> • Strategic direction to programs • policy development • Standard settings, norms and M&E indicators • Programme funding/resource mobilization • Prioritize and allocate financial resources • Epidemiologic analysis • Quality assurance • Training and support for district/sector programs and vector control 	<ul style="list-style-type: none"> • Coordination of emergency response • Evaluation & validation of operational research • Decision-making and planning of region programs/activities • Determine human resource needs • Monitor and evaluate district/sector IVM implementation
District Level	

-
- | | |
|--|---|
| <ul style="list-style-type: none"> • Local planning of implementation • Resource prioritization and allocation • Disease surveillance • Programme monitoring • Health education | <ul style="list-style-type: none"> • Train field district/sub-district health volunteers • Undertake vector control activities, assist in operational research • M&E: collection and initial collation of local data on various vector control aspects |
|--|---|
-

In partnership with MRTC and LBMA, a critical mass of entomology field technicians will be trained in the districts to support a full range of monitoring activities at sentinel sites Central entomology surveillance functions will be proactively carried out by MRTC to support IRS operations.

IRS requires a broad range of temporary field staff during spray operations (Box 2). As much as possible, these categories of workers will be selected from the targeted districts and sub-districts and will undergo short but standardized training immediately prior to each spray season to assure maximal protection of human health and environment. It will be necessary, as IRS operations expand across the country, to decentralize the training of temporary/seasonal field workers. Master trainers will therefore be installed in each targeted district or sub-district as may be appropriate and cost-effective, to organize the required training. As needed, PNLP will collaborate closely with district and sub-district political administration, as well as other relevant social/community governance structures, to identify the temporary IRS field workers.

Selected health facilities will be equipped to serve as reference points on insecticide poisoning within the districts. Health workers at these selected facilities will receive training on the management of insecticide poisoning.

Box 2:
Some Categories of RS Field Workers

Data Clerks
Drivers
Entomology technicians
Environmental compliance technicians
IEC/BCC workers
Procurement/logistics officers
Spray operators/supervisors
Warehouse keepers
Washers and disposal technicians

2e. Information management capacity

Surveillance is the continuous and systematic collection, analysis and interpretation of health data that are essential to planning, implementation and evaluation of health interventions.¹

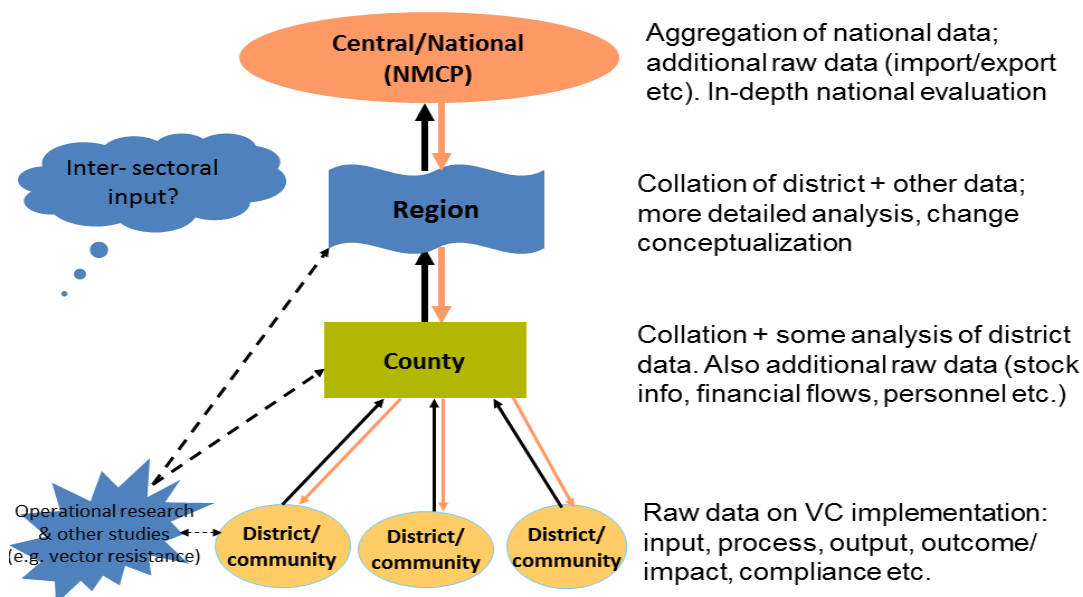
Timely flow of information among the central, regional, country and district levels is therefore critical to ensuring a sound basis IRS planning and implementation. Timely information will also enable correct assessment of the impact of the IRS and quick resolution of potential setbacks in the delivery of the intervention, as well as challenges posed by changes in the disease eco-epidemiology. Such eco-epidemiological changes may be either due to natural ecological reasons or brought about by the IRS operation (e.g. altered transmission potential). An integrated information system on IVM will be established, which will effectively support IRS operations in the following ways:

- i. Adequate capacity will be built at all levels for timely collection, management and utilization of data on the local vector species, disease eco-epidemiology, and progress in the deployment of interventions, outcomes and impacts. Indicators or data sets to be measured/collected will be identified and the frequency of measurement clarified. This will include input, process, output, outcome and impact indicators, and entomology indicators (Table 3), such as malaria incidence in sprayed houses compared to unsprayed. Standardized protocols will be used with robust quality control to protect the integrity of data from the points of collection/measurement up to the point of interpretation and utilization.
- ii. There will be regular communication/ dissemination of level-appropriate information to both internal and external clients (program implementers, service providers, policy makers at these levels, and the general population) to facilitate timely decisions to improve the outcome of IRS operations, as well as to ensure on-time decisions towards improved health outcomes. For example, district setups should be able to offer timely district-specific information on implementation, coverage and outcomes to local policy makers/implementers (district health management teams, district vector control coordinator etc.).
- iii. The capacity to effectively manage the expectation of policy makers and politically oriented concerns of the public is critical. The PNLP will therefore establish a proactive policy review mechanism to promote principled utilization of gathered scientific data.

¹ WHO (2005) *Malaria control in complex emergencies: an inter-agency field handbook* / World Health Organization. World Health Organization, Geneva Switzerland WHO/HTM/MAL/2005.1107. 218 p.

The establishment of a national entomology sentinel system is discussed elsewhere in this report. The sentinel system will form the core of vector control information system at the district level.

Fig.1. Routes for vector control data collection and management



2f. Evidence-Based Decision Making

The government will establish systems and human resources to adequately plan, implement, monitor and evaluate comprehensive IVM, to enable ongoing improvement in the targeting of IRS operations, and to maximize the overall impact on disease burden.

Entomology Monitoring

A credible capacity for entomological monitoring is critical for IRS, and will require the following, all of which will be established:

- i. Functional infrastructure (e.g. equipped insectary and associated entomological laboratory, sentinel sites)

- ii. Trained technical competencies (including central managers on entomology, entomology field technicians and laboratory technicians)
- iii. Vector surveillance and monitoring regime, with clearly defined indicators and standardized protocols.
- iv. Efficient data capture, management and utilization

Noting the pre-existing foci of resistance to DDT and other pyrethroids in the Mali, emphasis will be placed on entomological monitoring to provide a sound basis for managing insecticide resistance in the local malaria vector populations. Relevant national research assets such as the MRTC and LBMA will be mobilized to assist with surveillance and monitoring and to conduct critical operational research to clarify/fill existing information gaps. Institutional arrangements and roles will be clearly outlined to ensure ongoing and integrated support to malaria vector control implementation by the PNL.

Table 3: Desirable entomological monitoring indicators

BASIC Entomological evaluations (measured monthly) – Category 1:

- i. *Insecticide residual effectiveness (Cone bioassay)* – on major wall surface types (Mud, cement – painted or unpainted, and wood) in the localities where indoor residual activity is conducted. Provides rate of decay of the insecticide as expressed by 24 hour mortality of mosquitoes exposed to sprayed walls for 30 minutes.
- ii. *Night catches (indoor & outdoor)* - provides insight into biting behaviour of local vectors
- iii. *Pyrethrum spray catches* – Done between 6am and 8am at pre-selected houses. Indicator provides insight into vector entry into sprayed rooms over time. Compared with unsprayed homes and other higher category 2 evaluations on the catches (e.g. parity, sporogony, and blood meal analysis) provides insight on effectiveness of intervention and indicate transmission risk changes in sprayed rooms.
- iv. *Species identification (morphological) and composition* - from monthly catches listed above. It will mapping of vector distribution and tracking of any changes in species composition within the year

Entomological evaluations - Category 2

The Category 2 evaluations require advance training and access to relevant ELISA and PCR equipment.

The following indicators will be assessed:

- i. Sporozoite rates (quarterly) - provides insight into risk of getting malaria
- ii. Entomological inoculation rates (quarterly) – measure risk of getting malaria through infected bite
- iii. Blood meal analysis (half yearly) – provides insight into feeding preference of mosquito vector
- iv. Parity evaluations (quarterly) – denotes how effective intervention is
- v. Vector susceptibility evaluation (CDC) bottle assay- 2x/year for WHOPES approved insecticides

It is imperative that a comprehensive surveillance and monitoring scheme be established to cover the increased geographical spread of IRS operations as it is scaled up. A national scheme on entomology surveillance and monitoring will be established to track local vectors and evaluate impact of ongoing vector control interventions on malaria transmission. Sentinel sites will be set up and manned by the trained entomology technicians, who will conduct prescribed activities following standardized protocols. The sentinel sites will be linked with MRTC and LBMA

Epidemiological Monitoring

Periodic population-based cross sectional surveys such as the Malaria Indicator Survey or the Demographic Health Survey, do not provide information at the scale and detail that is necessary to adequately target and monitor IRS. Routine facility-based, parasitologically-confirmed monthly incidence data will be further strengthened and integrated with entomological surveillance datasets to enhance the assessment of the disease level impact of vector control efforts, facilitate progressive refinement of the targeting of IRS, and improve overall cost-effectiveness.

Operational and outcome indicators

Other IRS operational indicators which are vital to assessing input, output, and outcome of IRS operations that will be measured include: insecticide quantities used, amount of PPE utilized, percentage of eligible structures sprayed as a function of total structures counted, population covered (total, by gender, and by preferred age/groupings - under five year olds and pregnant mothers), percentage households receiving IEC/BCC services, persons receiving training (by category of work), and spray refusal rate.

Indicators such as cost per persons protected, where all cost categories are identified standardized, and quantified, will enable assessment of the cost-effectiveness and efficiency of the IRS intervention and also allow comparison with other vector control interventions.

Insecticide Selection for IRS

The following factors will be fully considered in the selection of an insecticide for IRS:

- Selected insecticides for IRS must be recommended by WHOPEs for IRS and registered in Mali for that purpose. Where such insecticides are not registered, the full national requirement for registration will be fulfilled prior to its importation, except where temporary exemption is provided by a duly authorized national agency under emergency conditions.
- The local vector populations in the IRS target areas must be susceptible to the insecticide formulation selected. This shall be ascertained using standardized WHO or CDC protocols. General WHO guidance for the interpretation of susceptibility rates will be followed. Due regard will be given to pre-existing foci of resistance. Where resistance exists, an insecticide with a different mode of action will be used as a resistance management strategy.
- The duration of IRS residual efficacy on sprayed surfaces: denotes the length of protection the insecticide will provide, when compared against the duration of the local malaria transmission period or the targeted transmission peak. Generally, longer duration of residual efficacy is desirable, provided the preceding criteria are fully met.
- Comparative cost of insecticide, with due consideration to length of residual efficacy, choice limitations imposed by existing vector resistance, as well as operational cost.

Management of resistance

A major area of concern for any insecticide based intervention is the development of insecticide resistance in the targeted vector(s). Particularly for Mali where there are pre-existing foci of Kdr resistance allele for DDT and pyrethroids, the management of insecticide resistance is a primary consideration in IRS operations. Results dating back 1987, show an association of Kdr allele with the Savanna form of *An gambiae*, and that the frequency of the allele has gradually increased over time², spreading to the Bamako form by 2007.³ The Kdr allele was detected in

² Fanello C, Petrarca V, della Torre A, Santolamazza F, Dolo G, Coulibaly M, et. al. (2003). The pyrethroid knock-down resistance gene in the *Anopheles gambiae* complex in Mali and further indication of incipient speciation within *An. gambiae* s.s. *Insect Molecular Biology* 12(3):241-5.

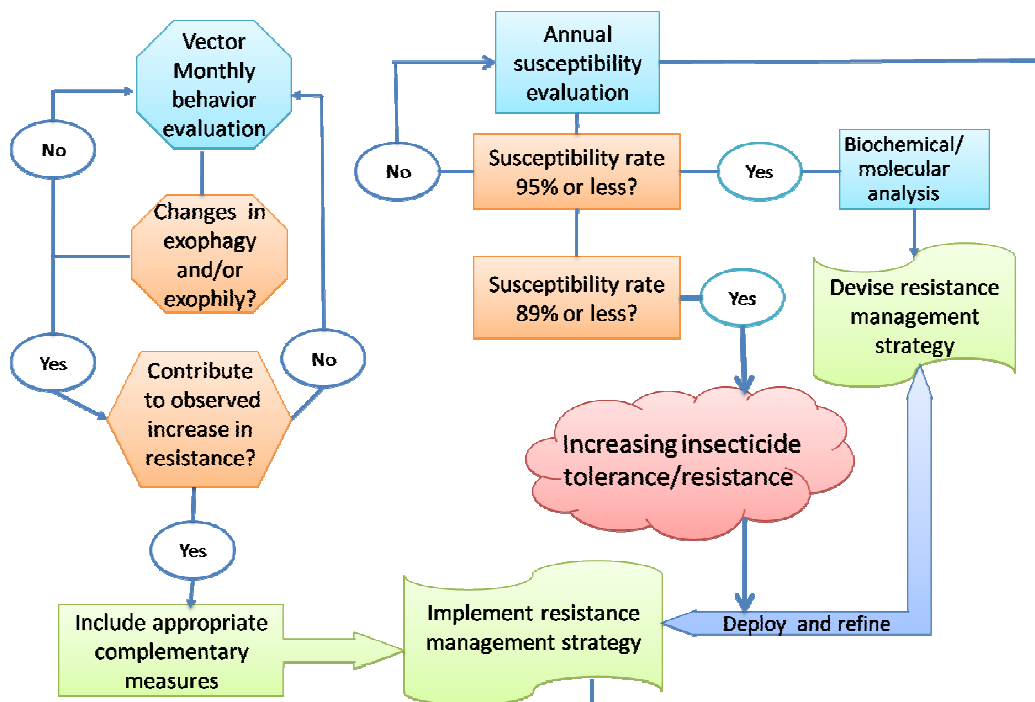
³ Tripet F, Wright J, Cornel A, Fofana A, McAbee R, et. al. (2007). Longitudinal survey of knockdown resistance to pyrethroid (kdr) in Mali, West Africa, and evidence of its emergence in the Bamako form of *Anopheles gambiae* s.s. *Am J Trop Med Hyg*.76(1):81-7

IRS campaign area after three years of spraying, as well in non-IRS areas that had received LLINs for a few years.

The above finding indicates a potential threat to the continued utility of IRS in the long term, if serious actions are not taken to manage the development of resistant alleles. MRTC and LBMA will be mobilized to proactively determine the levels, types and distribution of resistant alleles/mechanisms in the mosquito populations in Mali, to help shape a resistance management scheme at the very onset. Fig. 2 proposes a resistance monitoring and management regime that will be established:

- a. Entomology sentinel system will be established in IRS districts to ensure that representative sampling of the major ecological settings within IRS target, which may represent opportunities for distinct and/or variations in the vector populations.

Fig. 2: Resistance Monitoring and Management Scheme



- b. The susceptibility of the vector populations at the sentinel sites to WHOPES recommended insecticides for IRS, will be measured, to establish a baseline distribution. This will be followed by annual evaluation of vector susceptibility. A determination of susceptibility rate

of 95% or less will trigger annual biochemical/molecular evaluation of resistance mechanisms [Kdr, GSTs, Cytochrome P450s, Esterases, AchE (or MACE), and GABA], using either TaqMan Plasmodium Assay or Polymerase Chain Reaction (PCR). This will provide in-depth understanding of the local divers of the observed and assist the selection of insecticide with a different mode of action to help manage the development of the resistant strain(s) of mosquitoes. Where the baseline assessment indicates pre-existing elevated tolerance to insecticides, a six-monthly susceptibility regime will be established.

- c. Results on vector susceptibility will be fed into the WHO moderated regional database on insecticide resistance, to assist the development of regionwide strategies to manage insecticide resistance in malaria vector.

2g. Selection of IRS Target Areas

To support the achievement of the objectives of IRS strategy [see Section 1], IRS coverage will be expanded, building on the successes and lessons gained from current operations in Koulikoro, Bla, and Barouéli. The selection of IRS target areas will be informed by the following considerations, among others:

- i. *Areas with highest malaria burden* – from Fig 2-5 these are the southern areas of the country.
- ii. *Under-served areas, in terms of access to health services* - The strategic approach will be to prioritize and enhance disease prevention interventions in these areas.
- iii. *Ease of physical access* - IRS requires extensive logistics and movement of spray teams; remote areas with comparatively difficult access may increase the operational cost. The decision will focus on comparative cost and these areas may best be served with a robust LLIN intervention scheme that emphasizes maximal utilization. In all cases cost comparison and sustainability consideration will inform final decisions.

There are two broad strategic approaches to using IRS to control local malaria transmission and each imposes slightly different operational requirements:

- a. IRS may be deployed with the intention to quickly ‘crush’ transmission and force a lower transmission equilibrium. This strategic approach is captured by the first specific objective [**Phase 1**] of the IRS scale up strategy and usually relates to deployment in endemic areas, where the objective is to prevent the episodic upswings in transmission linked to rainfall, as well as depress the overall local vectorial capacity of the area, if possible. This “transmission crushing” approach will relate to the southern portion of Mali, where malaria is endemic and seasonal and includes current IRS operational districts of Koulikoro, Bla, and Barouéli, as well as the very southern strip of border regions with Guinea and Senegal, including Kadiola and Manankoro, where there is perennial endemicity.(Figs. 2-5). The first specific objectives underscore the importance of ensuring that the potential of IRS to significantly disrupt malaria transmission is harnessed to quickly impact areas of the country with the highest documented morbidity and mortality from the disease. The expansion of IRS within the endemic zone will be influenced by the existing level of access to health services, as well as ease of access to the target area.
- b. The second strategic approach is to use IRS to prevent and control epidemic outbreaks. For Mali, this will relate to the northern districts of the country with unstable transmission that are prone to epidemic outbreaks. Such strategic orientation will require credible epidemic prediction and preparedness capacities. In this context, surveillance becomes critical and in every sense is considered as an intervention of itself, as it becomes the primary tool determining the effectiveness of IRS. The experiences and lessons gained during the early years of scaling up [**Phase 1**] will enable the country to consolidate its capacities in the broad range of competencies and skills, infrastructure, institutional arrangements and policies that are critical to cost-effective and sustainable IRS implementation. The lead time will enable capacities to be developed to build towards the more challenging task of assuring timeliness in epidemic prevention and control, which is designated as **Phase 2**.

Fig 2:
Current IRS Districts (PNLP/PMI, 2011)

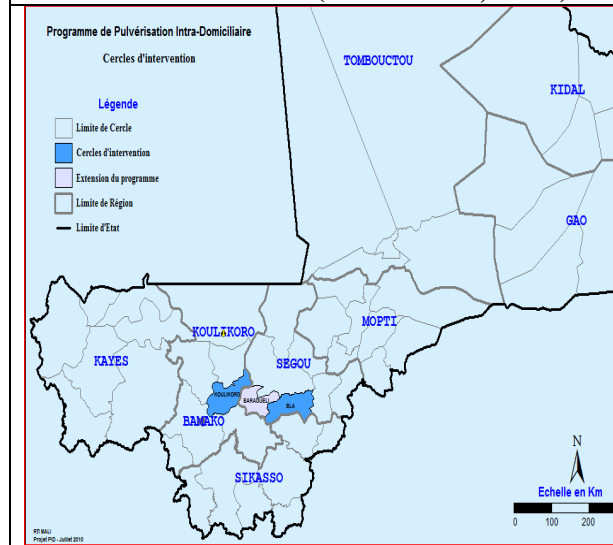


Fig 3
Malaria Prevalence Model (MARA, 2002)

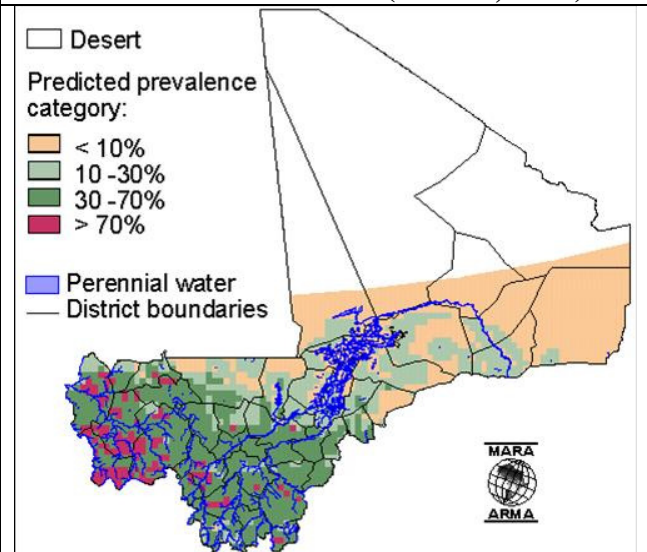


Fig 4:
Malaria Prevalence Model (MARA, 2002)

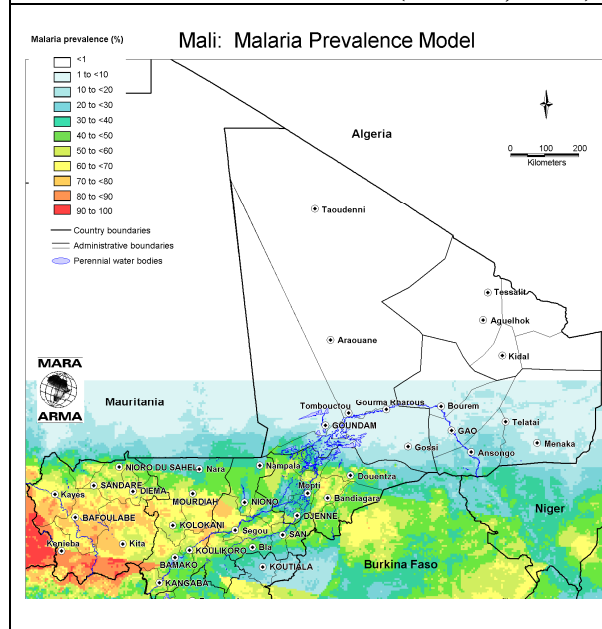
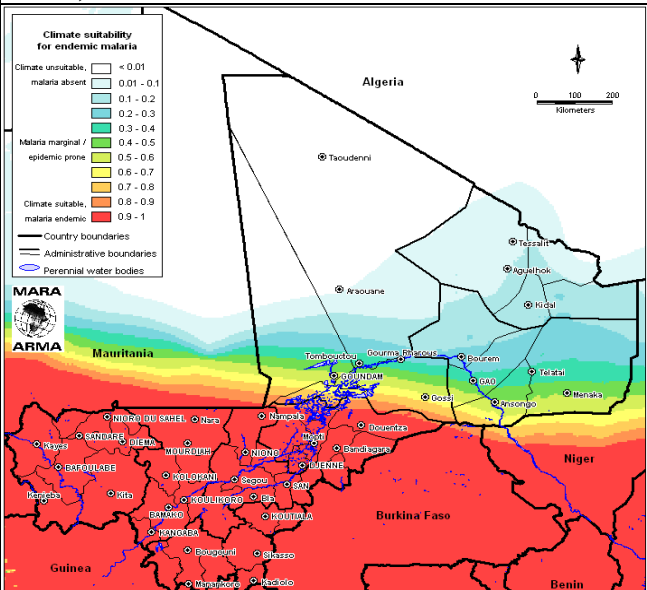


Fig 5:
Distribution of Endemic Malaria (MARA, 2002)



2h. On-going refinement of IRS, integration with LLIN deployment

The implementation of the strategic plan for IRS will be done within an overarching IVM strategy and will be closely coordinated with the LLIN implementation to optimize overall cost-effectiveness of the national malaria vector control effort and enhance management of insecticide resistance in local mosquito vectors. The coordination is also necessary for the eventual transition in the co-deployment of the two interventions in medium to long-term, especially as local transmission is successfully reduced and pre-elimination conditions are achieved in some geographical areas. Decisions of co-deployment will be underpinned by a very robust and integrated disease surveillance system and will draw upon recommendations of the WHO.

There is currently no firm methodology for determining the circumstances under which a combination of the two interventions (or what levels of combination) will have the maximal benefits, or the extent of any such benefit. As a general principle, WHO currently recommends⁴ that it will be beneficial to combine the IRS and LLN when a single intervention cannot completely cover all of the populations at risk, or achieve the maximal disruption of transmission possible. Based on current WHO recommendations, therefore, the following will generally guide the joint deployment of IRS and LLINs in Mali:

- The priority for Mali, in the short term, will be to achieve **universal coverage of all population at risk with IRS and or LLINs**.
- *In areas of intense transmission* - IRS will be used to accelerate reduction in local transmission and burden as a short to medium term strategy. LLIN deployment will be phased in with the aim of high utilization rate to sustain the reduced transmission.
- *In areas of moderate transmission* – Where universal coverage is achieved and it is determined that the impact of either LLINs or IRS alone is adequate, but unable to completely interrupt (break) local transmission, then the program will consider combining the two interventions as a means of achieving local interruption.
- *Low transmission area with a single peak* - IRS will be used to prevent the episodic peaking while maintaining high LLIN coverage throughout the year.

⁴ WHO (2010). *WHO Technical Consultations on combining Indoor Residual Spraying and long lasting insecticidal net intervention*. World Health Organization, Geneva Switzerland. 20 p.

- Unstable low transmission (epidemic prone) areas – IRS will be used as an epidemic prevention and control tool within the context of robust surveillance, with capacity for epidemic prediction and preparedness.

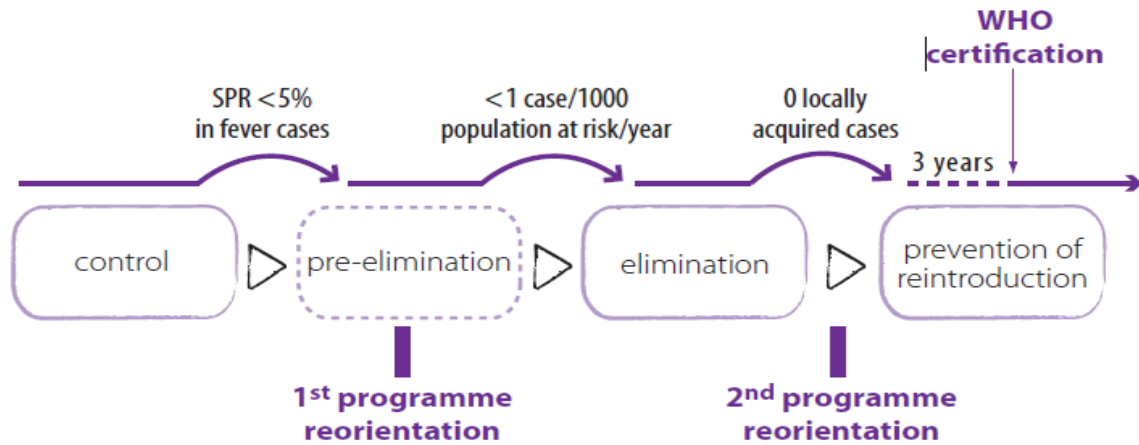
2i. Long term vision: Local elimination of malaria transmission

A desirable long term vision of every malaria intervention is to interrupt and hence eliminate local transmission. While this may remain a challenge for ecological settings that favor high and perennial endemicity, local elimination of malaria is conceivable in the northern regions of Mali where transmission is unstable (Phase 2 target areas). Fig. 3 presents the WHO program phase and milestones on the path to malaria elimination⁵. Noting that the border areas with Guinea and Sierra Leone share the highest burden, it is reasonable to assume that pre-elimination conditions (seropositive rate of less than 5% of febrile disease) cannot be attained in the southern most districts without some cross border collaboration.

In areas where pre-elimination is achieved, the aim is to reduce and maintain annual malaria incidence to below 1 case per 1000 persons at risk. The integrated approach will perfect the quality and targeting of both vector control and case management, in addition to transitioning to surveillance driven focal IRS and case management operations with the goal to prevent or reduce the spread of transmission from areas of residual transmission or new active foci. A strong surveillance system will need to be established at this stage, as surveillance moves from a supportive system to a mainstream vector control intervention tool (Fig 4). In areas where local interruption of malaria transmission is achieved, efforts will concentrate on preventing the re-establishment of local transmission, primarily through the spread from imported cases (from other areas of the country); this will prove most challenging given the very fluid within country movement of people.

⁵ WHO (2007). *Malaria elimination: A field manual for low and moderate endemic countries*. World Health Organization, Geneva Switzerland. 85 p.

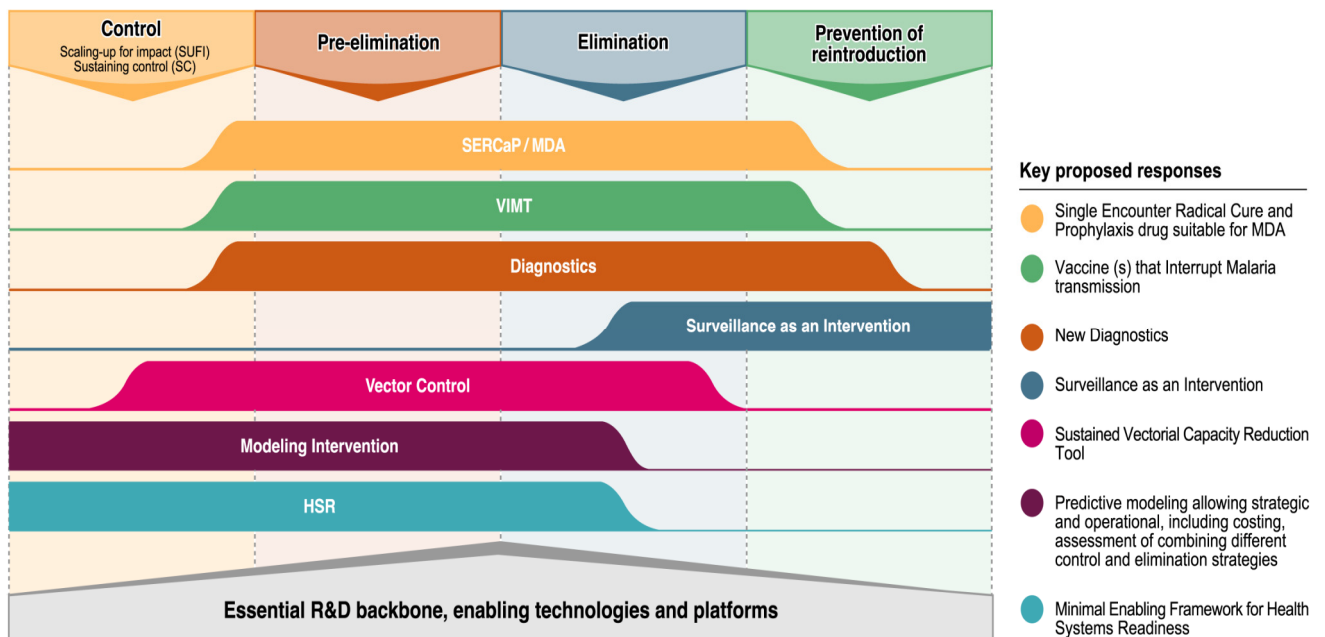
Fig. 3 Program Phases and milestones on the path to malaria elimination⁵



SPR: slide or rapid diagnostic test positivity rate.

^a These milestones are indicative only: in practice, the transitions will depend on the malaria burden that a programme can realistically handle (including case notification, case investigation, etc.).

Fig 4. Key research and development issues and their position in relation to the different epidemiological phases towards eradication⁶



⁶ Alonso PL, Brown G, Arevalo-Herrera M, Binka F, Chitnis C, et al. (2011) A Research Agenda to Underpin Malaria Eradication. PLoS Med 8(1): e1000406. doi:10.1371/journal.pmed.1000406

3. RESORCE MOBILIZATION

There will be deliberate efforts to mobilize dedicated financial resources for cost-effective implementation and expansion of IRS. A detailed, multi-year and fully-costed national IRS work plan will be developed, based on this strategic plan, and will form part of an overarching costed IVM work plan, which anticipates the deployment of LLINs, as well as other complementary vector control interventions. The IRS work plan will detail and cost all aspects of planning, managing, deployment and monitoring and evaluation, including staffing at all levels (long term and temporary field workers), community mobilization, forecasted procurement, storage and transportation, disposal, and data collection/management.

The IRS strategy and work plan will be used to mobilize in-country resources and facilitate targeted submissions to developmental partner sources, such as GFATM, World Bank, African Development Bank, and the Private Sector.

3.1 Encouraging Private Sector Investment in Malaria

Malaria is a major threat to private sector profitability as it is linked to disease-related absenteeism and reduced worker output. Malaria may therefore significantly raise the cost of labor. Private sector investment in workplace and community-based programs in malaria prevention programs has been shown to reverse the adverse impact of malaria on business operations and positively impact on productivity and profitability. Opportunities will be explored to enhance private sector input and public-private-partnerships (PPP) on malaria control including IRS. Modalities will be established to facilitate and acknowledge private sector ‘social responsibility’ initiatives in malaria control. In particular, companies (mining etc.) will be encouraged to establish, as necessary, vector control interventions, including IRS operations to cover staff, where the staff is located in well demarcated areas or townships